

Lighting the Way

New technology uses half the energy

Effective hangar lighting is a critical safety factor for Air Force personnel. Proper illumination of the work area results in safe, timely and accurate job accomplishment, and lighting improvements that boost morale and save energy provide triple the benefit. At the same time, Executive Orders currently mandate energy consumption reductions at federal facilities.

Members of the 92nd Civil Engineer Squadron at Fairchild Air Force Base, WA, recently accomplished a retrofit that met both requirements — dramatically improving lighting in two aircraft hangars while reducing energy use. As an added benefit, the lighting retrofit was funded from future energy savings, requiring no conventional appropriated funding.

Light Pipes

Fairchild civil engineers worked with the local electric utility, Bonneville Power Administration, and the prime contractor, Power City Electric, to install new lighting technology developed by 3M Company in the two hangars. Sixty-eight of the new lights, known as “light pipes,” replaced 286 pendant light fixtures in each hangar.

About 90 percent of the existing pendant light fixtures held 400-watt bulbs, while the other 10 percent held 1,000-watt bulbs. By contrast, each light pipe contains a single 1,000-watt metal halide bulb. The replacement cut lighting energy use in the hangars in half.

A light pipe consists of a housing at one end that contains the ballast and the 1,000-watt metal halide bulb, tube sections that reflect and evenly distribute the light, and a mirror at the other end.

The housing unit allows easy changing of the metal halide bulb by removing an access plate and sliding

the light out of one end. It has an ultraviolet light filter at the other end.

The tube sections are each 78.75-inch-long, 10-inch diameter polycarbonate with a rubber seal at each joint and locking tabs to ensure proper alignment and an airtight seal. A typical light pipe is made of six tube sections.

The polycarbonate tube sections are lined with an optical film to facilitate reflection of light down the full length of the light pipe at a variety of angles. The tube sections also have a reflective film on the top half of the section and are more transmissive on the bottom to send light down to the work surface. The reflective film tapers very slightly along the length of the light pipe to avoid transmitting light unevenly. Consequently, the light pipe sections must be installed in the proper order.

The mirrored end cap further increases the internal reflection of light at a variety of angles. The result is a very uniform distribution of light from one source over a wide area.

Maintenance and Installation

Maintenance of the light pipes should be minimal. As noted previously, the metal halide bulb is easily replaced. Internal cleaning is not required as the light pipe is sealed by rubber seals and held in place by locking tabs and coupling clamps at each joint. The polycarbonate sections are flexible and impact resistant, but do require care in handling to avoid scratching. Also, the internal reflective surfaces should not be touched or allowed to become dirty.

At the same time the light pipes were installed, infrared radiant heat was installed in the hangars. This led to the concern that the light pipes might become overheated. Data from 3M showed the maximum allowable temperature for the polycarbonate light pipe sections is 200 degrees Fahrenheit. The heater manufacturer’s analysis showed the maximum expected temperature would be less than 150 degrees. Infrared temperature measurements indicated that 114 degrees was the



maximum temperature encountered. In spite of this, six shields were installed per hangar to protect the polycarbonate sections.

Let There Be Light

There is literally a “day and night” difference between the new and old light systems in the hangars. The two side-by-side hangars are housed under one roof with two additional hangars, offices and shops inside a 500,000-square-foot aircraft maintenance building that was built

heavily supplemented by outdoor light. Thirty foot-candles came in through large glass areas in the hangar doors. But even with clean reflective paint on the hangar floor, only 2-4 foot-candles was available at 90 degrees to the hangar doors, and only 1-2 foot-candles was available 180 degrees from the hangar doors. These low levels of light posed a serious safety hazard to pedestrians in the hangar whenever vehicles drove through.

In contrast, the light pipes put

Lighting control was simplified considerably, as well. While each hangar is large enough to be wired into four separate panels, the new system is programmable and was set up to allow all the lights to be turned on or off from any one switch. Exempting any individual light from the program (to leave lights on as night lights, for instance) is as simple as pressing a pin for that individual light. It is possible to program lights to turn on or off at any desired time of day or week. If desired, the programming and monitoring can be accomplished from a remote computer, although this was not done at Fairchild.

Costs and Savings

The installed cost for lighting both hangars was \$1,186,784, including engineering design services. That comes to about \$8,725 per light pipe, with the majority being the material cost of the light pipe itself. Much of the light pipe assembly is done by hand. Greater production volume may decrease the price and also result in the housing becoming a single piece casting.

Energy savings performance contracting allowed the light pipe project to be coupled with the installation of infrared radiant heating and other energy-saving measures. The overall payback from energy savings was required to occur in less than 10 years. Under the same agreement, it is not necessary to do all the work at the same time, so energy savings exist which may be used for other projects in the future, such as installation of light pipes in two more hangars.

The most exciting part of the project, however, is that the occupants of the facilities are working in a far safer, more uplifting, more time-efficient environment, which results in dramatic cost savings in worker productivity, morale and job satisfaction.

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There is literally a “day and night” difference in the new and old lighting systems in the hangars. Photos show Hangar 1 (above) with light pipes installed and Hangar 4 (left) with the old pendant light fixtures. (Photos courtesy 92nd CES)

in the 1940s. The lighting that was replaced was the original lighting.

While comparing the completed installation in one hangar to the original lighting in the other, a visitor requested the not-yet-converted hangar’s lights be turned on. The answer readily came back, “Sir, the lights are on.” Subsequently, the decision was made to retrofit the remaining two hangars with light pipes.

The old pendant lights produced only 5 foot-candles of light, measured at 4 feet from the floor with a light meter pointed straight up at night. During daytime the old system was

out more than 50 foot-candles. Allowing for up to 30 percent degradation over time, the criteria of 40 foot-candles should be maintained in the long term.

Foot-candles are only part of the story. With conventional pendant fixtures, maintenance personnel looking up at a work surface with a bright light behind it would experience eyestrain. With light pipes, the hangar ceiling receives some light so that it is not entirely dark. As the light is uniform, it is relatively free of shadowing, contrast and glare. Moreover, it provides accurate color rendition.